

Quantum Relations

Transdisciplinary Expert Meeting on Quantum Mechanics and Meaning

On 12th and 13th December, the Expert Meeting entitled “Quantum Relations” was held at the Pontifical University of the Holy Cross, organised by the ROR Research Group and the DISF Research Centre of the same university, together with the Faraday Institute for Science and Religion in Cambridge and the Center for Science and Faith at the University of Copenhagen. The objective was to answer the following questions:

1. How real are quantum relationships?
2. Are they ontological or logical?
3. What is the result for our world-view?

The participants were: Kurt Appel (Vienna, Austria); Ivan Colagè (Rome, Italy); Johan Fynbo (Copenhagen, Denmark); Stefano Furlan (Utrecht, Netherlands); Pui Him Ip (Cambridge, UK); Oskari Juurikkala (Rome, Italy); Sebastian De Haro (University of Amsterdam); Mark Harris (Oxford, UK); Giulio Maspero (Rome, Italy). A specific characteristic of this Expert Meeting was to bring together speakers from different disciplinary areas, but with dual expertise in both scientific and philosophical-theological fields. A first result has been that the experience of the poverty of each participant’s language, when confronted with the specifics and technical difficulty of others’ experience, allowed the question of meaning to be addressed in an open and relational way.

1. The discussion on the question “How real are quantum relations?” revolved around the central themes of the role of the observer, the notion of information, and the importance of context in the study of quantum phenomena. The example of John A. Wheeler’s thought showed the relevance of a profound relational dimension of reality. Whilst an “observer” need not necessarily be a human being for quantum events to occur, Wheeler still attributed to conscious observers a specific role. At first, in the mid-1970s, also spurred by anthropic considerations on the seeming fine-tunedness of natural constants, he wondered whether conscious observers could be considered as a condition of possibility for the existence of the universe itself. Later on, he revised these ideas but kept a crucial role for them: without conscious observers and their relation in a “super-Copernican” community across spacetime, no “meaning” could emerge in the universe. In the discussion, Wheeler’s notion of information and its causality attracted the attention of the participants. This is, in some ways, closer to the cybernetic understanding, initiated by N. Wiener, in which information is essentially “instruction” that influences in a causal way the recipient’s behaviour, rather than to the classical understanding, as in Shannon, which views it as non-semantic signal. This cybernetic vision is, in a certain sense, more relational. This points to the importance of context, as quantum phenomena are intrinsically dependent on the context in which they occur, whether natural or a precise experimental set-up. Scientists sometimes maintain that the phenomenon is not only what happens within the apparatus, but is the complete whole: the process and the context, the phenomenon and the arrangement. Bohr’s approach, according to which we cannot speak of the phenomenon without experiment, is also in some sense relational.

2. However, to grasp whether such relationality occurs only at a logical level or at an ontological level too, it was necessary to analyse quantum phenomena, such as duality or quantum chaos, together with the incompleteness that has emerged both in the logical domain and in that of information theory. This has made it possible to grasp how the relational dimension is not merely a property of theories, but is a property of theories because it emerges as a property of

reality itself, as Carlo Rovelli's relational interpretation of Quantum Mechanics shows, through its possibility of connection with field theory and general relativity. In this approach, the physical variables of a system acquire discrete values only through relations with another system. This can be read according to a linguistic (and musical) analogy: classical physics is semantic as it supposes the possibility of directly mapping mathematical signs to reality through absolute values; in contrast, quantum physics, unable to assume absolute values for the wave nature, lends itself to a syntactic approach, where the theory is a framework for describing the interrelation between signs, just as a melody essentially emerges from intervals between notes. This syntactic approach presents relations as a bridge between the ontological and the logical, that seems to correspond to the fundamental relational nature of reality.

3. This relational perspective sees Quantum Mechanics and its limitations with respect to other physical theories, e.g. General Relativity, not as a *limes*, i.e. limit as separation and closure, but as a *limen*, i.e. threshold of reciprocal opening, between different disciplines and domains of reality, including theological metaphysics. This means that it is impossible to absolutely separate physics from metaphysics (and therefore from theology), because relationality itself refers to the dimension of meaning. Thus every discipline can aspire to be coherent to the extent that it recognises itself as incomplete and, therefore, open. In this way, quantum (and classical) indeterminism has relevance for theology, especially for the Divine Action Problem (DAP), that touches upon the fundamental debate between voluntarism (things are good because God willed them) and rationalism (God willed them because they are good). Consequently, quantum relations inevitably refer to a worldview, which cannot fail to engage with other worldviews. The compatibility of such worldviews will depend precisely on their degree of relationality. For example, a monist conception, which eliminates every distinction, seems to contradict the relationality that emerges from Quantum Mechanics, because every relation is constituted by identity and distinction, where both the former and the latter have the same foundation (as in the unity and distinction of a father and a son). From this point of view, the role of relations which emerges from the quantum perspective, both at a logical and ontological level, also seems to respond to the fundamental metaphysical tension that, from the confrontation between Parmenides and Heraclitus, has afflicted philosophical thought, due to the impossibility of holding together the one and the many. By contrast, from the point of view of Christian revelation, the work carried out by the Church Fathers to recognise the distinction between the Father and the Son as purely relational, yet real, within the single eternal and infinite substance of God, proves to be open to the results of contemporary research.

The final outcome of the Expert Meeting was relational, first and foremost because of the network of networks that was created between the participants and that they wish to develop with physicists, philosophers and theologians. This will make it possible to clarify the meaning of terms, which in itself is also relational. Indeed, as Bohr said that we are suspended in language, we must also say that language does not exist by itself, but is suspended in communities. For this reason, it is necessary to clarify together, in the real relations among the participants in the project, what ontology, emergence and even orthodoxy mean for each person. Recognising the importance of an "honest dialogue" that unites the technical dimension with the search for meaning, it is concluded that quantum relations are neither exclusively logical nor exclusively ontological, but are both.